A 12VDC HYDRAULIC PRESS
INTRODUCTION
by Robert D. [Dan] McMurray

September 18, 2008

During the fall of 1998, I designed and built the double acting hydraulic press described in the attached article. As originally designed, the press can easily and quickly exert over 7,000 pounds of force on the ram. I have actually built 1 1/2" whistle rockets on my press.

The copyrighted article was originally published in three parts in the Pyrotechnic Artists of Texas (PAT) newsletter during 1999. As I state in the article, the press was not the first of its kind to be built; however, it predated the other 12VDC designs seen at the PGI by a year or two. I have never seen another article on how to build this kind of hydraulic press.

Since the article was first published, Rob Westfall and I have made several improvements to the original design. In particular, a two layer polycarbonate “safety shield” is added to the front of the press, the steel "C" channel is replaced with 6" X 3" aluminum “C” channel extrusion nominally 1/2" thick, the press plates are shortened to 12”, and the zinc plated steel All-Thread, nuts, and washers are replaced with stainless steel. These changes make the press portion safer and lighter, as well as corrosion resistant. Rob uses foot-switch operated, solenoid controlled power units on his presses. I still feel that the manually controlled power unit provides more precise ram positioning.

For just rocket work, the press plates could be shorter than 12”; however, that change makes the press less stable during transport and setup. For shorter rocket work, a shorter cylinder and closer press plate spacing could be used. Naturally, those changes must be reflected in the “safety shield” dimensions.

The polycarbonate “safety shield” is simply two sheets of polycarbonate 12” X 24” X 3/8” mounted to the top and bottom press plates using 3/8”-16 X 6” zinc plated All-Thread stand-offs. Two stand-offs are threaded into the top press plate and two more into the bottom press plate, positioned to just clear the “back” of the “C” channel, and locked into place with zinc plated jam nuts. Stand-off spacing on each press plate is 8” (i.e., 4” each side of center). Each polycarbonate sheet is drilled to match the four stand-offs.

Looking from the outside, the polycarbonate sheets are attached to the stand-offs with the following 3/8”-16 fasteners, in order: Stainless cap nut, fender washer, polycarbonate sheet, fender washer, polycarbonate sheet, fender washer, and wing nut, with wings turned toward the press plate. Except for the cap nut, all of the hardware is zinc plated. This arrangement allows the “safety shield” to be installed and removed without tools.

Just as a note, I recommend using Grade 5 screw couplings instead of Grade 2 (or Grade UNKNOWN) screw couplings for mounting the hydraulic cylinder onto the upper press plate. Originally, I used Grade 2 screw couplings because that was what I could get at the time. The Grade 2 couplings worked and are still working; however, today I would use Grade 5 screw couplings. A source for polycarbonate (i.e., Lexan is the General Electric trade name) sheet and 5/8”-11, Grade 5 screw couplings is McMaster-Carr at www.mcmaster-carr.com.

ALTERNATIVE POWER UNITS

Double Acting Power Units

The primary advantage to building a double acting hydraulic press for making rockets is that there is the ***potential*** to extract the drift from the rocket tube after pressing a rocket. To allow the press to extract the drift from the rocket tube, the drift must be attached to the ram. I have done this using a 1-ton arbor press; however, I have yet to implement the approach on a hydraulic press. Perhaps, next year …

The Dalton DB-1660 double acting hydraulic power unit shown in the following link looks to be the same as the power units Rob Westfall is using on his latest presses:

http://stores.daltonhydraulic.com/-strse-250/DC-Hydraulic-Power-Unit%2C/Detail.bok

According to the documentation, the SPX Stone (a division of Fenner Fluid Group) model number is 250-230.

Rob Westfall says there is an issue with this power unit – the solenoid operated direction control valve does not have a "center closed" position. When the pump and direction control solenoids are energized and then de-energized, the direction solenoid returns to the "rest" position while the pump continues to drive oil through the "rest position" port until it spins down. Assuming the “extend” port on the cylinder is connected to the “rest position” port on the pump, this means that the ram "bounces" or extends about 1/2" after the switch is released while retracting the ram. Rob commented that while trying to carefully position the ram, the “bounce” was more of an irritant than a real problem.

To address the issue, Rob added a 12VDC solenoid operated hydraulic valve (Rob says it cost about $60) on the “rest position” pump port. Rob's press is configured so that the output of the direction solenoid "rest position" port and solenoid valve on the pump are connected to the “extend” port of the cylinder. The solenoid valve opens when the pump is energized and closes when the pump is de-energized. Rob says the “bounce” is totally eliminated.

After carefully examining several “inexpensive” power units, I believe that the MTE 250-749-4 double acting power unit shown in the following link may be a better choice:

http://stores.daltonhydraulic.com/-strse-248/DC-power-unit%2C-hydraulic/Detail.bok

Based on the hydraulic schematic, this power unit should also exhibit the “bounce” issue, which can be addressed in exactly the same manner as with the DB-1660. The single benefit of selecting this unit is that it is rated for more flow and pressure than the original power unit I recommended or the power units I specify as my preferred alternative.

As my preferred alternative, contact SPX Stone at:

http://www.stonehydraulics.com/

I recommend either the DC-50F product or the DC-60SF product. The DC-50F looks to be the power unit that I originally purchased from W. W. Grainger and described in the article. The DC-60SF is a solenoid operated power unit with a separate solenoid for "up" and "down" and a "center closed" position. If you want solenoid controlled operation, the DC-60SF seems to be a "best" choice. If you have a Stone Hydraulics Service Center near you, you may be able to get a refurbished unit and save some money. I did not find a surplus source for these SPX Stone power units.

DISCLAIMER: I BUILT A DOUBLE ACTING HYDRAULIC PRESS. IF I BUILD A SINGLE ACTING HYDRAULIC PRESS, I WILL USE THE FOLLOWING APPROACH.

Single Acting Power Units

If the double acting power units I suggested are too much of a load on your pocketbook, you might consider using a single acting power unit. Be careful to select a single acting power unit with an adjustable relief valve that lifts the load, then "holds" the load until the lever is moved or the solenoid is energized to "lower" the load. The SPX Stone DC-10F and DC-20SF look to be such units.

The MTE single acting power unit shown at the following link also looks to be such a unit:

http://stores.daltonhydraulic.com/-strse-249/DC-power-unit%2C-hydraulic/Detail.bok

As with the double acting MTE power unit referenced above, the single benefit of selecting this unit is that it is rated for more flow and pressure than the SPX Stone power units.

A NOTE: *In double acting hydraulic systems, the hydraulic cylinder serves as a reservoir for most of the oil needed to operate the system. Thus, with the 2.5" hydraulic cylinder, the required double acting power unit reservoir is small (i.e., less than 1 quart).*

In single acting hydraulic systems, there is no oil reservoir in the hydraulic cylinder. Thus, the reservoir on a single acting power unit needs to be large enough to supply all of the oil transferred to the cylinder. Before purchasing a single acting power unit, be sure the reservoir is large enough to accommodate the hydraulic cylinder you select.

A Single Acting Hydraulic Cylinder

The easy way to make a hydraulic cylinder for use with a single acting power unit is to use a double acting cylinder and charge the cylinder through the "retract" port with a small amount of oil and a "low pressure" or "LP" gas like R-22 refrigerant or Propane (also called R-290 refrigerant).

Using a low pressure gas for this purpose eliminates the need for the large external gas reservoir used on some single acting designs. When properly charged, the low pressure gas becomes a liquid as the ram extends and changes from liquid to gas as the ram retracts. Regardless of the ram position, the gas pressure is constant. Further, the approach requires a minimum of hydraulic hardware as shown in Table B below.

For reference, Table A shows hydraulic hardware from the major suppliers WW Grainger, Inc (www.grainger.com) and Surplus Center (www.surpluscenter.com). The least expensive source for most of these parts is Surplus Center.

WARNING: EXCEPT FOR THE FLARE CONNECTION VALVE, THE RECOMMENDED FITTINGS ARE DESIGNED FOR HYDRAULIC USE AND AS SUCH ARE RATED FOR 4,500 PSI. DO NOT SUBSTITUTE OFF-THE-SHELF PLUMBING FITTINGS FROM THE LOCAL HARDWARE STORE FOR THESE FITTINGS.

CLEAN EVERYTHING BUT THE INSIDE OF THE HYDRAULIC CYLINDER AND POWER UNIT! DIRT AND DEBRIS ARE THE NUMBER ONE ENEMY OF HYDRAULIC SYSTEMS!

DO NOT USE TEFLON TAPE ON HYDRAULIC SYSTEMS! *Loctite* makes a thread sealant product specifically for hydraulic applications (W. W. Granger part number 5A237, *Loctite* part number 54531).

Low Pressure (LP) Gas

For this application, a gas having several characteristics is required:

1. The gas must be compatible with hydraulic (mineral) oil.
2. The gas must not swell hydraulic O-rings or attack steel or chrome plating.
3. When the ambient temperature is between 30^{o} and 105^{o} F, the gas must liquefy at a pressure between 50 PSI and 200 PSI.
4. The ideal gas should be non-flammable; however, because a very small amount of gas is used and this is a sealed system, flammability is not really an issue.

At least two (2) readily available products have these characteristics: R-22 refrigerant and Propane. In my opinion, R-22 or a similar refrigerant is the ideal; however, I have not tried it. The fellow who tried R-22 said that the hydraulic cylinder "locked up"; even though there was ample pressure to retract the ram. His assumption (and mine) is that the R-22 caused the O-rings in the cylinder to swell. According to the fellow who built the single acting hydraulic cylinder of this design, Propane is the product of choice.

Assembling "Retract" Port Hardware

The "retract" port hardware should be mounted on the hydraulic cylinder before the cylinder is mounted on the upper press plate. For safety, the hardware should be oriented as described in the following procedure:

1. Install the Union Flare Connection Valve, Connection Type 1/4 Inch MNPT with Cap, into one of the opposing connections of the 1/4" FNPT Tee

2. Install one end of the 1/4" MNPT to MNPT Hex Nipple into the Tee connection opposite the Flare Connection Valve.
3. Install the female end of one 1/4" 90° MNPT to FNPT Street Elbow onto the Hex Nipple. Orient the male end of the Elbow opposite to the open end of the Tee.
4. Install the 600 PSI Pressure Gauge into the female end of the other 1/4" 90° MNPT to FNPT Street Elbow. Orient the male end of the Elbow toward the back of the Gauge. **BE CAREFUL NOT TO OVER-TIGHTEN THE GAUGE.**
5. Install the male end of the Street Elbow/Gauge Into the exposed end of the Tee. Orient the top of the Gauge in the same direction as the Flare Connection Valve. The Assembly is now complete.
6. Remove the plastic shipping plug from the both ports of the hydraulic cylinder.
7. Using clean, pressurized air through the "extend" (i.e., clevis pin end) port, fully extend the ram. Turn the hydraulic cylinder over and drain any excess oil out of the cylinder through the "retract" (i.e., Ram end) port.
8. Reposition the cylinder so that the ports are on top. Using a suitable syringe, inject about 1cc of clean hydraulic oil into the "retract" port opening.
9. Using clean, pressurized air through the "retract" (i.e., ram end) port, fully retract the ram.
10. Install the 3/8" MNPT - 1/4" FNPT Bushing into the "retract" port of the hydraulic cylinder.
11. Install the male end of the Street Elbow on the Assembly into the "retract" port of the hydraulic cylinder. Align the Assembly with the axis of the cylinder so that the Cap on the Flare Connection Valve points toward the clevis pin end of the hydraulic cylinder.

At this point, the single acting hydraulic cylinder is assembled. When the hydraulic cylinder is mounted on the upper press plate, the Cap on the Flare Connection Valve points toward the ceiling while the face of the "retract" port gauge points toward the side of the press. Should any component of the assembly fail, the press operator should be safely out of the way.

Leak Testing the Single Acting Hydraulic System

Once the press is assembled and connected to the hydraulic power unit, but prior to charging the single acting hydraulic cylinder, the hydraulic system must be tested for leaks.

Leak testing should be carried out as follows:

1. With the press in the vertical position and the ram retracted into the hydraulic cylinder, use the power unit control to extend the ram until the "retract" port gauge indicates between 50 PSI and 100 PSI. To insure all of the air is removed from the "extend" portion of the hydraulic cylinder, retract the ram and repeat the cycle several times. Because the air in the "retract" portion of the cylinder is not initially under pressure, the ram will not fully retract during this step.
2. Examine all of the connections for leaks. When a leak is identified, use the power unit control to release all hydraulic pressure and repair the leak. If leaks are found and repaired in the "retract" port fittings, it may be necessary to use clean, compressed air through the Flare Connection Valve to retract the ram. Repeat steps 1 and 2.
3. Extend the ram until the "retract" port gauge indicates 200 PSI, 300 PSI, and 600 PSI and repeat step 2 after each pressure increase.

Charging the Single Acting Hydraulic Cylinder

This operation is best carried out after the press is completely assembled and tested. The charging operation should be carried out in a well ventilated area, away from open flames, and using proper safety gear to protect your eyes and hands.

Ideally, the Propane used in this procedure should come from a small can of R-290; however, R-290 in small cans is hard to find in the U. S. of A. If you have access to R-290, R-12/R-22 refrigerant service gauges can be used directly. To access Propane fuel gas, however, you will need to build an adapter to connect the Propane gas container port to a male Flare Connection Valve or to a 500 PSI hose with a female Flare Connection fitting attached.

An obsolete single-can device used to add R-12 to automobile air conditioning systems is a good source for a hose with a female flare connection valve fitting attached. Obsolete R-12/R-22 refrigerant pressure/vacuum gauges, with service hoses attached, can be found at yard sales and flea markets for $5.00 to $10.00. If required, Propane fuel gas fittings and flare fittings are available from an RV dealer or from your local ACE or True Value hardware store. For additional details, see the section titled "**Throwaway Propane Cylinder to Flare Connection Adapter**"

The charging procedure is as follows:

1. With the press and hydraulic cylinder in the operating position and the ram retracted, remove the Cap and Schrader valve core from the Flare Connection Valve.
2. With the Flare Connection Valve open to air, use the single acting hydraulic power unit to fully extend the ram. **WHENEVER THE POWER UNIT IS OPERATING, KEEP YOUR FACE AND HANDS AWAY FROM THE FLARE CONNECTION VALVE OPENING.**
3. At this point, air must be removed from the "retract" end (i.e., Ram end) of the hydraulic cylinder. There are two (2) options for accomplishing this task:
   A. If you have access to a refrigeration vacuum pump and pressure/vacuum gauges, install the Schrader valve core into the Flare Connection Valve, connect the pump/gauges to the Flare Connection Valve, and use the pump/gauges to purge and evacuate

TABLE B – "Retract" Port Hardware List

Description	Quantity	Unit Cost	Total Cost	Notes
3/8" MNPT - 1/4" FNPT Bushing	1	1.95	1.95	Stock No. 2F435
1/4" 90° MNPT to FNPT Street Elbow	2	6.55	13.10	Stock No. 2F469
1/4" MNPT to MNPT Hex Nipple	1	1.72	1.72	Stock No. 2F453
1/4" FNPT Tee	1	9.25	9.25	Stock No. 2F475
Pressure Gauge, 600 PSI, 1/4" MNPT Lower Mount Gauge	1	7.95	7.95	Item# 21-5130
Union Flare Connection Valve, Connection Type 1/4 Inch MNPT with Cap	1	10.14 (Package of 6)	10.14 (Package of 6)	Stock No. 3GD01
Total Cost			**$ 44.11**	

"Stock No." parts are from W. W. Grainger, Inc. "Item" parts are from Surplus Center.

the hydraulic cylinder in exactly the same manner as would be done to a refrigeration system.

B. If you do not have access to a refrigeration vacuum pump and pressure/vacuum gauges, you will have to settle for purging the cylinder as follows:

a. Connect a charging hose from the LP gas container to the Flare Connection Valve.

b. With the LP gas container in the upright position, open the valve on the LP gas container.

c. Using the hydraulic power unit control, fully retract the ram into the hydraulic cylinder.

d. Close the valve on the LP gas container and remove the charging hose from the Flare Connection Valve.

e. With the Flare Connection Valve open to air, use the single acting hydraulic power unit to fully extend the ram.

f. To insure that all of the air is removed from the "extend" portion of the hydraulic cylinder, repeat steps a. through e. several times.

g. With the ram fully extended, install the Schrader valve core into the Flare Connection Valve.

h. Connect the charging hose from the LP gas container to the Flare Connection Valve.

4. With the ram still fully extended, invert the LP gas container and hold the LP gas container higher than the Flare Connection Valve.

5. Open the valve on the container, wait a second or two, and close the valve on the container. NOTE: Gravity should cause liquid to flow into the hydraulic cylinder. If too little liquid is transferred, warm LP gas container with hot water before repeating steps 4 and 5.

6. Using the hydraulic power unit control while observing the "retract" port pressure gauge, retract the ram.

   When the hydraulic cylinder is properly charged, the "retract" port pressure gauge will indicate approximately the same pressure regardless of the ram position.

   When the indicated pressure drops as the ram retracts, the hydraulic cylinder is **undercharged**. Repeat steps 4 through 6 until the indicated pressure remains constant.

7. Using the hydraulic power unit control while observing the "retract" port pressure gauge, fully extend the ram.

When the ram is almost fully extended, <u>slow down and watch the "retract" port pressure gauge for a pressure indication at or over 250 PSI</u>.

If the "retract" port pressure gauge indicates 250 PSI or more, stop extending the ram. The hydraulic cylinder is overcharged. If the ram is fully extended in the overcharged state, the "retract" port pressure gauge can be damaged. Gas must be released from the cylinder before the ram can be fully extended.

To correct the overcharge condition, disconnect the charging hose from the Flare Connection Valve. Using a small screwdriver, carefully depress the Schrader valve to release a small amount of gas/liquid from the system. Repeat steps 6 and 7.

WHEN RELEASING GAS FROM THE SYSTEM, KEEP YOUR EYES, FACE, AND BARE FINGERS AWAY FROM THE FLARE CONNECTION VALVE.

8. After the hydraulic cylinder is properly charged, set the LP gas container in the upright position, disconnect the charging hose from the Flare Connection Valve, install the Flare Connection Valve Cap, and remove the adapter from the LP gas container.

<u>OPERATION AND MAINTENANCE</u>

The single acting hydraulic press is operated in virtually the same manner as the double acting hydraulic press. The primary differences being at initial setup, each time the press is used, and when the press is removed from service.

When the press is initially connected to the power unit, be sure the quick connect fittings are clean.

As the first step when the press is ready for use, fully extend and retract the ram while observing the "retract" port gauge.

- If the indicated pressure increases while extending the ram, the hydraulic cylinder is undercharged and must be recharged. When this occurs frequently, the most likely cause is that the hydraulic cylinder ram seal is leaking. The cylinder must be discharged, rebuilt/replaced, and recharged.
- If the indicated pressure close to maximum ram extension rises to or above 250 PSI, stop extending the ram. The most likely cause of this condition is that hydraulic oil has leaked into the "retract" portion of the

hydraulic cylinder. The cylinder must be discharged, rebuilt/replaced, and recharged.

As the last step before shutting down the press for disassembly and/or storage, fully retract the ram.

THROWAWAY PROPANE CYLINDER TO FLARE CONNECTION ADAPTER

A flare connection adapter can be easily built for use with "throwaway cylinders" (disposable propane tanks).

Many disposable propane tanks are equipped with a 1"-20 male connector that mates with torches, lanterns, and other consumer devices. Female 1"-20 to 1/4" MNPT and 1/4" flare to 1/4" MNPT adapters are readily available from most RV dealers and from some hardware stores. With the addition of a valve and a refrigeration charging hose, the adapter is complete.

A parts list is as follows:

- Mr. Heater #F273754 1"-20 Female Throwaway Cylinder to 1/4" male pipe thread (MNPT) adapter (see Figure 2, left) from ACE Hardware with the same stock number for $10.99 (in store for $7.99).
- 1/4" Male Flare Connection (MFL) to 1/4" male pipe thread (MNPT) adapter from ACE Hardware for $2.99.

  For this part, a "Union Flare Connection Valve, Connection type 1/4" MNPT with Cap", W.W. Granger Stock No. 3GD01, as specified for use in the Single Acting Hydraulic Cylinder section (see Figure 2, right) can be used. These valves can only be purchased in a package of 6. For this application, be sure to remove the Schrader Valve.
- 1/4" female pipe thread (FNPT), full port, ball valve from ACE Hardware, Stock No. 4161089 for $9.49 (in store for $6.99).
- R-12, R-22 Refrigeration Charging Hose with a 1/4" female flare connector (FFL) permanently attached to both ends. The female flare connecter on one end is equipped with a Schrader valve depressing device (See Figure 3). The female flare connector on the other end is open. This hose, with a can-piercing valve, is available from AutoZone in a kit, Part Number 461, for about $9.99.

Using thread sealant or Teflon tape on each pipe thread, adapter assembly is straight forward as follows:

- Open the valve (i.e., position the handle parallel to the valve body).
- Screw the 1/4" MFL to 1/4" MNPT adapter into the end of the valve farthest from the handle.
- Close the valve (i.e., position the handle perpendicular to the valve body).
- Screw the 1"-20 Female Throwaway Cylinder to 1/4" MNPT adapter into the end of the valve opposite the 1/4" MFL to 1/4" MNPT adapter.
- Connect the end of the Charging Hose without the Schrader valve depressing device onto the 1/4" MFL fitting.

The Throwaway Propane Cylinder to Flare Connection Adapter is ready for use (see Figures 4 and 5).

30° F, the pressure drops to around 50 psi.

PRESSURIZING WITH PROPANE

In a propane container containing both liquid and gas, part of the volume is occupied by liquid and part is occupied by gas. The pressure of the gas is governed by the temperature of the liquid as shown in Table A.

From liquid to a vapor, propane expands 270 times its liquid volume.

At 70° F:

- Liquid propane can only exist at a pressure of about 110 psi.
- At atmospheric pressure, 1 in^3 (i.e., 16.4 cc) of liquid propane, weighing about 0.3 oz (i.e., 8.4 grams), boils to produce about 270 in^3 of propane gas.

With the 1 1/8" diameter ram fully retracted, the internal volume in the ram end of a 2.5" diameter hydraulic cylinder is about 63 in^3.

At 70° F in a volume of 63 in^3:

- 1 in^3 of liquid propane boils to produce propane gas at about 63 psi.
- Around 1.8 in^3 of liquid propane boils to produce propane gas at about 110 psi – the pressure at which liquid propane is still present in the volume.

Given that a tablespoon measure is about 30 cc, slightly more than 1 tablespoon of liquid propane will pressurize the ram end of a 2.5" diameter hydraulic cylinder to 127 psi at 70° F. At 105° F, the pressure rises to around 185 psi.

Table A - Vapor pressure of Liquid Propane at Various Temperatures

Liquid Temperature (°F)	Approximate Gas Pressure (psi)
30	51.6
40	63.3
50	77.1
60	92.5
70	109.3
80	128.1
90	149.3
100	172.3
110	197.3

Notes about propane

In the purest form, propane is an odorless, colorless gas that liquefies at a relatively low pressure. In many parts of the world, propane is referred to as "Liquefied Petroleum Gas" or "LPG". As commonly delivered, a skunk, rotten egg or garlic odorant is added

to indicate leaks. Propane is air flammable in concentrations of 2% to 10%.

According to the MSDS, as delivered under the name Coleman Propane in 1 lb tanks the product contains small amounts of propylene (<20%), Ethane(<6%), n-Pentane (2.5%), and, the odorant, ethyl mercaptan (<0.1%).

For further information on propane from Coleman, check out:

http://www.coleman.com/coleman/msds/propane.pdf

Figure 1 - Adapter Hardware – From Top to bottom, Left to right: Charging Hose, Cap, 1/4" MFL to 1/4" MNPT Adapter, 1/4" FNPT Ball Valve, Female 1"-20 to 1/4" MNPT Adapter

Figure 2 - Adapter Fittings: Female 1"-20 and Union Flare Connection Valve, Connection type 1/4" MNPT with Schrader Valve

Figure 3 - Female Flare Fitting Attached to the Charging Hose with Schrader Valve Depressing Device

Figure 4 - Completed Throwaway Propane Cylinder to Flare Connection Adapter with Valve Turned Off

Figure 5 - Completed Throwaway Propane Cylinder to Flare Connection Adapter with Valve Turned On

A 12VDC HYDRAULIC PRESS

(Part 1 of 3)
by Robert D. (Dan) McMurray

Over the past few months, a number of people have asked about the hydraulic press Rob Westfall and I used for making rockets at Caddo Mills, at Gillette, Wyoming, and, most recently, at Fulshear, Texas. This is the first in a series of three articles on the press. This article describes the origin and design of the hydraulic rocket press. The second and third articles will describe press assembly and safe operation and maintenance.

HISTORY: The portable hydraulic press idea first surfaced at the 1998 Western Winter Blast. A pyro Mechanical Engineer named Guy Leictenwaller (the spelling may be wrong) had a home-built hydraulic press that he had just finished making. Guy had it hooked up to a car battery (12VDC) in the back of his van and made rockets with it during the entire weekend. It was neat! Just pull the lever to press a spoon full of fuel and push the lever to release the ram. Pressing was quick, repeatable, and (most of all) painless. Guy could make a 1" diameter whistle rocket in about ten (10) minutes.

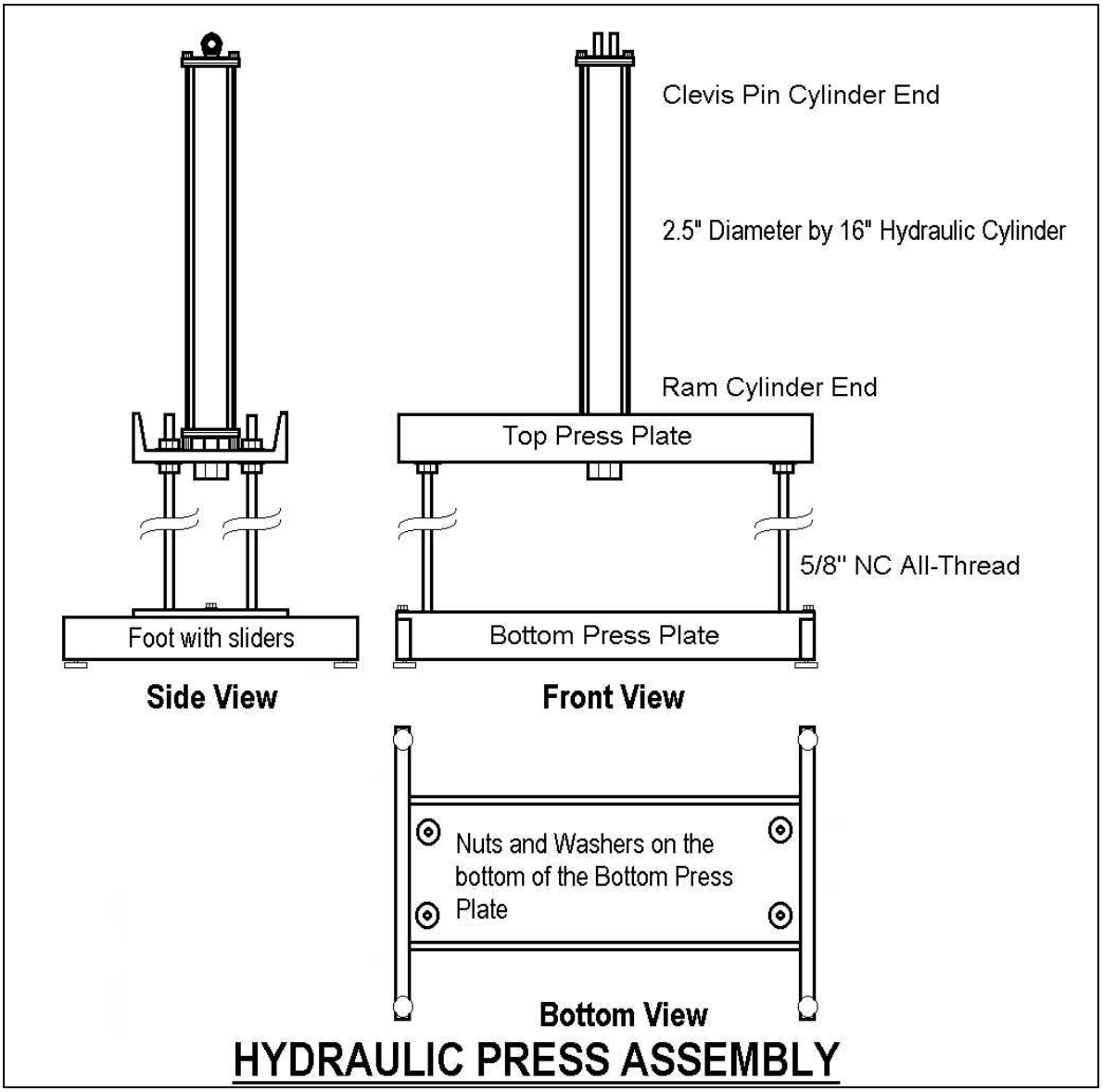
When Rob and I returned to Dallas after the WWB, we started looking for places to buy hydraulic parts. We even tried to find a commercially built device similar to Guy's press. We found no "used" (read surplus and inexpensive) hydraulic parts sources in the Dallas area. Eight hours of Internet searching did not turn up a commercially built device similar to Guy's press. After a month of looking and talking, we decided to purchase the hydraulic parts new and fabricate the press frame from scrap materials.

GUY'S PRESS: The press consisted of two (2) assemblies: a press assembly with hydraulic ram, and a 12 volt DC hydraulic power unit with integral reservoir and control valve. To allow easier transport, hydraulic hose with quick disconnects was used between the assemblies. In operation, the hydraulic power unit can be connected to a car battery or to a hefty battery charger running on house power (120 volt AC).

Based on the WWB demonstration, a 1" whistle rocket needs about 2,000 lbs of pressure. Guy's power unit seemed to be straining to press a 1" rocket.

THE NEW DESIGN: After a lot of discussion, Rob and I decided that we wanted a portable press similar to Guy's that could press whistle rockets up to 1 1/2" in diameter. We settled on a 2 1/2" diameter, double acting ram, 16" long, and rated at 2,500 PSI. Based on the WWB demonstration and the 2 1/2" diameter ram, a 1" whistle rocket only needs 400 PSI hydraulic pressure. A 1 1/2" whistle rocket needs about 1,000 PSI, which is well within the specification of available power units. In hopes of using the release stroke of the ram for extracting drifts, we decided that the power unit also needed to be double acting.

The ram was purchased from Northern Hardware on Campbell Road and Central Expressway in Dallas, Texas. It



is a 2.5" X 16" "tie rod" cylinder used in agricultural applications. The cylinder has a chrome plated, 1 1/8" diameter ram and is commonly available. I believe that the cylinder is rated at 2,500 PSI and cost around $80.00. The particular cylinder was chosen because the nuts could be removed from both ends of the tie rods. On the cylinders manufactured by "Prince", the nuts at the top of the tie rods look to be welded to the tie rod, which will hinder mounting.

The hydraulic power unit was purchased from W. W. Grainger, Incorporated, as a "Manual Directional Power Unit", part number 4Z338. The Grainger unit is rated at 3,000 PSI, 2.1GPM @500PSI, with an externally adjustable, relief valve common to both ports and a pilot operated check valve on one port so that the ram will hold position after the pump is shut off. I believe that the Northern Tool & Equipment "3-Position, Manually Controlled, 12 volt Hydraulic Power Unit for double acting cylinders" (page 46 Catalog #133) is similar, but only rated at 2,000 PSI and 1.2GPM. The catalog says that their unit has "check and relief valves", but I am not sure where the check valve is located or how many there are. If you can buy with a large company discount (like TI), both units cost about $400.00.

A set of four (4) relief valve springs were purchased after market (another $20.00) to get the pressure relief down to the 0 to 1,000 PSI range. I believe that the extra relief valve springs should have been with the unit, but they were not there and we did not know to look for them until too late.

The fittings were purchased off-the-shelf from Grainger. I have forgotten how many "L"s, "T"s, adapters, and couplings were used. The most expensive fittings are the quick disconnects. Each quick disconnect has a male and a female part. **YOU ONLY NEED TWO (2) - NOT FOUR (4).** Mount a quick disconnect coupler on one end of each hose. Permanently mount the free end of the shorter hose to the ram end of the cylinder. Permanently mount the free end of the longer hose to the check valve port of the power unit. Mount a quick disconnect nipple to the clevis pin end cylinder port. Mount the other quick disconnect nipple to the power unit port without the check valve. To keep the fittings clean when you disconnect the hydraulic hoses, connect the quick disconnect coupler on the cylinder hose to the quick disconnect nipple on the cylinder. Do the same for the power unit.

All of the fittings that we used are NPT thread - all fittings are 1/4" NPT except for the 1/4" NPT to 3/8" NPT adapters used on the cylinder ports.

Because the ram sits on top of the press, the hoses are different lengths. The top hose is 8' long while the bottom is only 7' long. The hoses are 1/4" I.D. and were purchased ready-made with 1/4" NPT fittings attached from "Surplus Center" (telephone 1-800-488-3407). Because of the short lengths and low flow rate, 1/8" I.D. hoses could have been used. The advantages are that the 1/8" hose is slightly less expensive and a lot more flexible. The disadvantage is that 1/8" I.D. hose comes with 1/8" NPT fittings that need to be adapted to the 1/4" NPT fittings.

A 4" diameter, stainless steel, 1,500 PSI pressure gage with a 1/4" NPT fitting was also purchased from "Surplus Center". The gage is mounted to a fitting on the check valve port of the power unit. Because the gage is delicate and prone to damage, it was plumbed in low at the back of the power unit. It is not as convenient to read as it would be in other locations, but it has not yet been damaged.

The press frame is made from two (2) identical pieces of 6" steel "C" channel, 18" long purchased from the local scrap yard. These are called the top and bottom press plates. The plates are oriented such that the flat sides are facing each other. I do not know the "weight" of the channel; however, the width measures 6", the "legs" measure 1.935", and the web measures .210". The press plates are separated by four (4) pieces of 5/8" NC zinc plated all-thread, 26 inches long (again, scrap yard material).

To keep as much of the bottom press plate as possible available as a work surface, the four (4) holes in the bottom press plate are threaded. To make sure that the all-thread stays adjusted and does not pull through the "C" channel, a washer and nut are placed inside of the "C" channel on the lower side of the bottom press plate. The top press plate has four (4) 5/8" holes drilled to mirror the holes in the bottom plate. The top plate is held in position by a nut and washer on each side and can be adjusted up or down.

To stabilize the press assembly when the cylinder is mounted, a solid aluminum foot measuring 5/8" X 1 1/2" X 12" was attached at each end of the bottom press plate. The "legs" of the "C" channel were cut back 5/8" and two (2) 1/4" holes were drilled in the overhanging edge of the web. The aluminum bars were drilled and taped to accept 1" long 1/4"-20 bolts. Each "foot" is attached with one (1) 1/4"-20 X 1" stainless steel bolt with washer in the center of each "web" overhang as shown in the press illustration. The relief in the "C" channel "legs" keeps each "foot" in position without using a second bolt. To eliminate corrosion, the "feet" were attached to the bottom press plate with stainless steel bolts and washers. As a final touch, the ends of each foot were drilled and tapped 1/4"-20 to accept adjustable metal sliders. When the press is set up, the sliders are adjusted to keep it from rocking. I am not sure where I got the aluminum bars (or when or how much they cost), but I am sure that once up on a time they were scrap yard materials. I believe that I spent about $3.00 on the sliders.

The reinforcing plate is a 6" length of 6" "C" channel, mounted flat sides facing and oriented 90^{o} to the top press plate. The reinforcing plate is attached to the top press plate with the hydraulic cylinder mounting bolts. The press will work without the reinforcing plate, but the hydraulic cylinder tends to jump up and down at pressures over 500 PSI.

In the second article, press assembly will be presented. In the third and final article of the set discusses safe operation and maintenance of the 12VDC Hydraulic press.

A 12VDC HYDRAULIC PRESS
Part 2 of 3 - Assembly

This is the second in a series of three (3) articles on building a 12 VDC Hydraulic press. The first article described the origin and design of the hydraulic rocket press. This article describes press assembly. The third article addresses press operation, maintenance, and safety.

The first items in this article are diagrams and parts lists showing the location, quantity, orientation, dimensions, approximate cost, and availability of everything needed to build the press. Costs shown do not include sales tax.

TABLE 1 – Hardware and Electrical Parts List

Description	Quantity	Unit Cost	Total Cost	Notes
6" wide "C" channel X 18"	***2***	$ 1.00	$ 2.00	Local scrap yard
6" wide "C" channel X 6"	***1***	1.00	1.00	Local scrap yard
5/8" 1 1/2" X 18" Aluminum Bar	***2***	1.00	2.00	Local scrap yard
1/2" X 9" X 18" Aluminum Plate	***1***	5.00	5.00	Local scrap yard
1 1/8"-12 Nut (Zinc Plated)	***1***	2.60	2.60	
5/8"-11 X 26" All-Thread	***4***	4.00	16.00	
5/8"-11 Nuts	***12***	.30	3.60	
5/8" SAE Flat Washers	***12***	.25	3.00	
3/8"-16 Screw Couplings	***4***	1.25	5.00	
3/8"-16 X 1 1/4" Grade 5 Bolts	***4***	.25	1.00	
3/8" SAE Flat Washers	***20***	.07	1.40	See Note 1
1/4"-20 X 1" SS Bolts	***2***	.20	.40	
1/4" SS Flat Washers	***2***	.10	.20	
1 1/16" Pad, 1/4"-20 Threaded Adjustable Glides	***8***	3.50	7.00	Metal or Plastic pad
3/8"-16 X 1" FH Allen Screws	***2***	.50	1.00	Steel or Stainless Steel
1/4"-20 Nuts	***4***	.05	.20	
5/16" ID X 1/2" conical expansion springs	***4***	----------	----------	Home built from 0.042 stainless fishing leader
5/16"-24 X 1 1/4" SS Bolt	***1***	.25	.25	
5/16"-24 SS Nut	***1***	.10	.10	
5/16"-24 Wing Nuts	***2***	.35	.70	Zinc Plated or Stainless
#2 Automobile Jumper Cables	***1***	40.00	40.00	Auto Zone Auto parts
Marine Battery Accessory Connector with 5/16" NC Stud and Wing Nut	***2***	2.57	2.57	Wal-Mart
#2 Compression type Cable Connector with single 5/16" hole	***4***	.25	1.00	Local electronics surplus store
Total Cost			**96.02**	

Note 1 - A selection of different thickness washers is needed to align the hydraulic cylinder.

Unless otherwise noted, all parts are purchased at a local hardware store; however, almost all of the parts are available from W.W. Grainger, Inc.

PRESS FRAME ASSEMBLY: Once the top and bottom press plates, the reinforcing plate, "feet" and springs are complete and you have four (4) lengths of All-Thread, plus the associated nuts, washers, and glides, you are ready to assemble the press frame.

Start with the bottom press plate. Screw each piece of All-Thread into a threaded hole in the bottom press plate until it extends about 1" below the plate. Adjust each piece of All-thread until about 25" extends above the bottom press plate. Install a 5/8" SAE washer and a 5/8"-11 nut on each piece of All-thread below the plate. Torque the nuts to 70 to 90 foot-pounds.

The "feet" can then be installed on the bottom press plate. First install the threaded adjustable glides with conical compression springs on each "foot" and then mount the "foot" on the bottom press plate with the 1/4"-20 X 1" stainless steel bolt and 1/4" stainless steel washer.

With the bottom press plate standing on the "feet", install a 5/8"-11 nut and 5/8" SAE washer on the top of each piece of All-thread. Screw each nut down until about 1" of All-thread extends above the washer. Set the bottom press plate aside until the hydraulic cylinder alignment step below.

Hydraulic Cylinder Mounting: The hydraulic cylinder is "face mounted" to the top press plate with the 1 1/8" ram extending through a 1 1/4" hole in the top press plate. Face mounting is accomplished by replacing the four (4) tie rod nuts on the ram end of the cylinder with four (4) 3/8"-16 screw couplings. The modified hydraulic cylinder is then attached to the top press plate with four (4), 3/8"-16, grade 5 bolts. The bolts pass through holes in the reinforcing plate and top press plate into the screw couplings.

First, replace the tie rod nuts on the ram end of the hydraulic cylinder with screw couplings, align the screw couplings, and re-torque the tie rods to between 20 and 25 foot-pounds.

Remove the plugs from the ports on the hydraulic cylinder. Until the plugs are replaced, be careful not to get dirt into the cylinder ports. Manually pull the ram out of the hydraulic cylinder about two (2) inches. Remove the clevis pin attachment from the end of the hydraulic cylinder ram by loosening the set screw and then unscrewing the attachment. If the ram turns with the clevis pin attachment, grasp the ram with soft jaw pliers and unscrew the attachment. If you do not have soft jaw pliers, place a leather belt between the pliers and the ram. **BE CAREFUL NOT TO SCORE, SCRATCH OR NICK THE RAM**.

With the hydraulic cylinder ports oriented toward one end of the top press plate and the reinforcing plate oriented at 90° to the top press plate, attach the reinforcing plate and top press plate to the hydraulic cylinder using four (4) 3/8"-16 X 1 1/4", grade 5 bolts and 3/8" SAE washers. Snug up the bolts, but do not torque them down until the ram is aligned. Screw the 1 1/8"-12 nut onto the end of the ram.

Place the top press plate, with hydraulic cylinder mounted, onto the All-thread in the bottom press plate and let it rest on the 5/8" SAE washers. Place a 5/8" SAE washer onto each piece of All-thread followed by a 5/8"-11 nut. At each corner, measure the distance between the top and bottom press plates. Align the top and bottom press plates by turning the nuts supporting the top press plate until the distance between the top and bottom press plates at each corner is the same. Once the plates are aligned, torque the top most 5/8"-11 nuts to between 70 and 90 foot-pounds.

With the press assembly standing on its "feet", grasp the 1 1/8" nut on the end of the ram and pull the ram out of the hydraulic cylinder as far as it will go. Remove the nut from the end of the ram. Using a square, verify that the ram is perpendicular to the bottom press plate. If the ram is not perpendicular to the bottom press plate, insert combinations of various thickness 3/8" SAE washers between the screw couplings and the top press plate until the condition is corrected. Once the ram is perpendicular to the bottom press plate, torque the 3/8"-16, grade 5 bolts to between 20 and 25 foot-pounds.

Replace the 1 1/8" nut on the end of the ram. Unless you are ready to connect the hydraulic fittings and hose to the hydraulic cylinder, replace the plugs in the hydraulic cylinder ports.

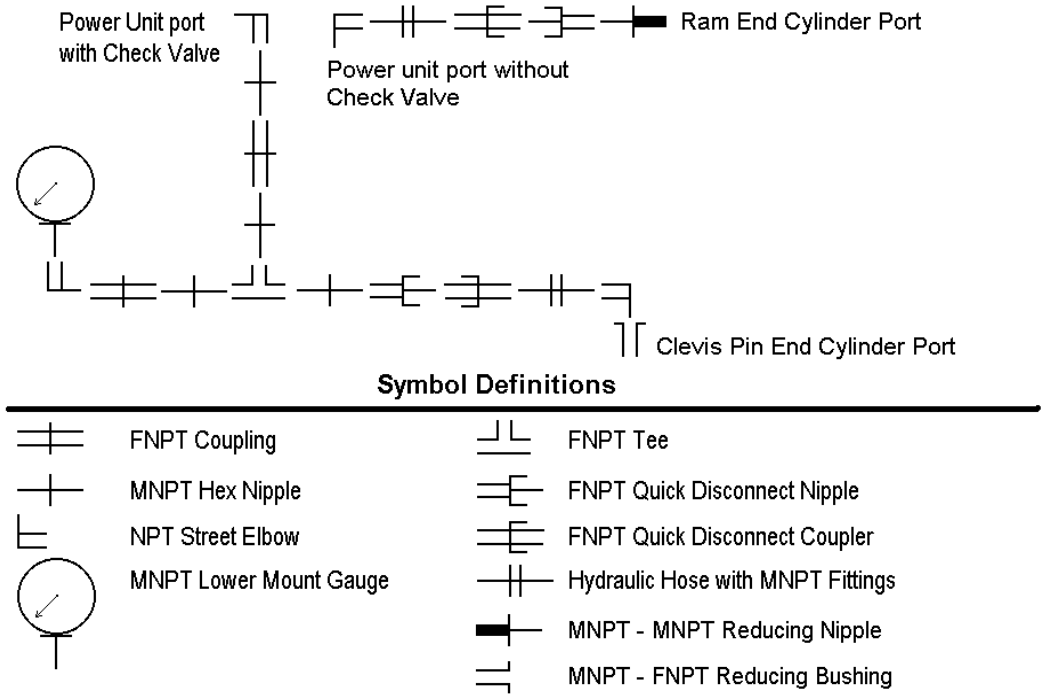

Power Unit port with Check Valve
Power unit port without Check Valve
Ram End Cylinder Port
Clevis Pin End Cylinder Port
Symbol Definitions
FNPT Coupling
MNPT Hex Nipple
NPT Street Elbow
MNPT Lower Mount Gauge
FNPT Tee
FNPT Quick Disconnect Nipple
FNPT Quick Disconnect Coupler
Hydraulic Hose with MNPT Fittings
MNPT - MNPT Reducing Nipple
MNPT - FNPT Reducing Bushing

Figure 2 - Hydraulic Plumbing Diagram

Install the Hydraulic Fittings: The next step is to install the hydraulic fittings and hose onto the press assembly. Before starting, **CLEAN EVERYTHING BUT THE HYDRAULIC CYLINDER AND POWER UNIT! DO NOT USE TEFLON TAPE ON HYDRAULIC SYSTEMS!** *Loctite* makes a thread sealant product specifically for hydraulic applications (W. W. Granger part number 5A237, *Loctite* part number 54531).

Examine the hydraulic plumbing diagram. The gauge & most of the fittings attach to the power unit. The following fittings & hose attach to the press assembly:

- 3/8" MNPT - 1/4" FNPT Bushing
- 1/4" Street Elbow
- 1/4" X 8' hose with 1/4" MNPT fittings
- 1/4" FNPT - Quick Disconnect Coupler
- 3/8" MNPT - 1/4" MNPT Hex Nipple
- 1/4" FNPT - Quick Disconnect Nipple

Before each connection is made, apply a thin layer of *Loctite* thread sealant to the male pipe thread. The layer should be located toward, but not on, the

TABLE 2 - Hydraulic Parts List

Description	Quantity	Unit Cost	Total Cost	Notes
Manual Directional Hydraulic Power Unit	1	$431.00	$ 431.00	Fenner DC-50 Stock No. 4Z338
Adj. Relief Valve Assembly (RV-2)	1	20.00	20.00	Parts Company of America 1-800-323-0620
Hydraulic Cylinder - 2.5" X 16"	1	80.00	80.00	Northern Tool Lion 25TL16-112
3/8” MNPT Hydraulic Filter Breather	1	6.49	6.49	Item 9-026-A
4" Diameter, 1500 PSI, 1/4” MNPT, Stainless Steel, lower mount Gauge	1	11.95	11.95	Item 21-1310
1/4” X 8' hose with 1/4” MNPT fittings	1	13.65	13.65	Item 916-1496
1/4” X 7' hose with 1/4” MNPT fittings	1	12.35	12.35	Item 916-1484
1/4” FNPT Quick Disconnect Coupler	2	17.47	34.94	Stock No. 2F543
1/4" FNPT Quick Disconnect Nipple	2	6.24	12.48	Stock No. 2F555
1/4” Street Elbow	4	5.20	20.80	Stock No. 2F469
1/4” FNPT Coupling	2	2.60	5.20	Stock No. 2F481
1/4” FNPT Tee	1	7.33	7.33	Stock No. 2F475
1/4” MNPT Hex Nipple	4	1.35	5.40	Stock No. 2F453
3/8" MNPT - 1/4” MNPT Hex Nipple	1	2.21	2.21	Stock No. 2F455
3/8” MNPT - 1/4” FNPT Bushing	1	1.35	1.35	Stock No. 2F435
Total Cost			**$ 665.15**	

"Stock No." parts are from W. W. Grainger, Inc. "Item" parts are from Surplus Center

smaller end of the fitting and fill at least one (1) thread completely around the fitting. Connect the hydraulic parts in the following order:

1. Install the Quick Disconnect Coupler on one end of the 8' hose.
2. Install the 3/8" MNPT - 1/4" FNPT Bushing onto the 1/4" Street Elbow.
3. Install the Quick Disconnect Nipple on the 3/8" MNPT - 1/4" MNPT Hex Nipple.
4. Remove the plug from the port at the clevis pin end of the hydraulic cylinder and install the Street Elbow and Bushing into the port. Position the FNPT end of the Street Elbow toward the ram end of the cylinder.
5. Install the 8' hose with Quick Disconnect Coupler into the Street Elbow.
6. Remove the plug from the port at the ram end of the hydraulic cylinder and install the 3/8" MNPT - 1/4" MNPT Hex Nipple and Quick Disconnect Nipple into the port at the ram end of the hydraulic cylinder.

At this point, the Hydraulic Press Assembly is complete. Wrap the hose around the cylinder, connect the Quick Disconnect Coupling to the Quick Disconnect Nipple, and set the Press Assembly aside until the Power Unit Assembly is complete. Show it to your wife and/or friends. Fabrication of the Press Assembly is a major accomplishment.

POWER UNIT ASSEMBLY: The power unit assembly supplies the hydraulic pressure to drive the hydraulic cylinder on the Press Assembly. All cautionary notes concerning hydraulic assembly apply to the power unit as well as the hydraulic cylinder.

Assuming the Fenner power unit is used, the first steps in the assembly are to replace the relief valve spring and relocate the electrical solenoid from the port side of the power unit to the control lever side.

The relief valve spring and ball are located under the silver cap on the control lever side of the power unit. Remove the cap and "O" ring, remove the threaded stud, replace the spring with the 1,000 PSI to 2,000 PSI spring from the RV-2 kit, replace the threaded stud (screw it into the hole only about 1/4"), and replace the "O" ring and cap. If you drop anything, be sure to clean it before you put it back into the power unit.

Solenoid relocation is accomplished in the following steps:

1. Disconnect the two (2) control wires from the solenoid. Disconnect the motor end of the heavy cable connecting the solenoid and the motor.
2. Loosen the solenoid mounting clamp.
3. Slide the solenoid 180^{o} around (under) the motor and tighten the mounting clamp. The final position should place the solenoid just below the control lever.
4. Remove the nut on the lower solenoid stud, put the control wire with the large diameter connector on the stud, replace and tighten the nut. Install a 5/16"-24 wing nut on the stud. **The stud is the positive terminal of the power unit.**
5. Form and reconnect the cable to the motor terminal.
6. Reconnect the last control wire.

Power unit assembly begins with connecting the hydraulic parts and is completed with assembling hardware parts. Examine the hydraulic plumbing diagram. The hydraulic assembly uses the following parts:

- Manual Directional Hydraulic Power Unit
- 3/8" MNPT Hydraulic Filter Breather
- 4" Diameter, 1500 PSI, 1/4" MNPT, Stainless Steel, lower mount Gauge
- 1/4" Street Elbows (3 required)
- 1/4" MNPT Hex Nipple (4 required)
- 1/4" FNPT Coupling (2 required)
- 1/4" X 7' hose with 1/4" MNPT fittings
- 1/4" FNPT - Quick Disconnect Coupler
- 1/4" FNPT - Quick Disconnect Nipple

Before each connection is made, apply a thin layer of *Loctite* thread sealant to the male pipe thread. The layer should be located toward, but not on, the smaller end of the fitting and fill at least one (1) thread completely around the fitting. Connect the hydraulic parts in the following order:

1. Install a 1/4" MNPT Hex Nipple in each end of the 1/4" FNPT Tee.
2. Connect a 1/4" Street Elbow, a 1/4" MNPT Hex Nipple, and a 1/4" FNPT Coupling together and install the assembly on the 1/4" MNPT Hex Nipple in the center of the FNPT Tee. Orient the Street Elbow at 90^{o} to the Tee.
3. With the Tee down, the Street Elbow up, and the male thread on the Street Elbow facing away from you, install the 1/4" FNPT - Quick Disconnect Nipple on the right hand side of the Tee.
4. Install a 1/4" Street Elbow into a 1/4" FNPT Coupling.
5. With the Tee down, the Street Elbow up, and the male thread on the Street Elbow facing away from you, install the 1/4" FNPT Coupling and Street Elbow on the left-hand side of the Tee. Orient the new Street Elbow parallel to the Tee with the FNPT end up.
6. Install the 4" Diameter, 1500 PSI, 1/4" MNPT, Stainless Steel, lower mount Gauge into the FNPT end of the 1/4" Street Elbow. The face of the gauge faces the same direction as the exposed male thread on the Street Elbow.
7. Install the assembly produced in steps 1 through 6 into the power unit port having the pilot check valve. On the Fenner power unit purchased from W. W. Grainger, the port is labeled "B". As the assembly reaches its final position, the fit is close. Be careful not to catch or scratch the gauge during installation. The final position of the assembly when facing the port side of the power unit is with the gauge on the left.
8. Install a 1/4" Street Elbow in the power unit port without the pilot check valve. On the Fenner power unit purchased from W. W. Grainger, the port is labeled "A". When facing the port side of the power unit, the Street Elbow FNPT connection points to the right.

9. Install the Quick Disconnect Coupler on one end of the 7' hose and install the other end of the hose into the FNPT end of the Street Elbow.
10. Until hardware and electrical assembly of the power unit are complete, connect the Quick Disconnect Coupling to the Quick Disconnect Nipple.
11. Remove the plastic filter breather from the power unit and replace it with the 3/8" MNPT Hydraulic Filter Breather purchased from Surplus Center. Once you are sure that the new breather is a satisfactory fit, dispose of the plastic filter breather as befits a poorly implemented low cost idea (e.g., send it to someone you don't like, send it back to Fenner, break it, trash it and/or make it disappear).

Once the hydraulic assembly is complete, hardware and electrical assembly can begin. The power unit assembly is made from the following hardware and electrical parts:

- 1/2" X 9" X 18" Aluminum Plate
- 1 1/16" Pad, 1/4"-20 Threaded Adjustable Glides (4 required)
- 1/4"-20 Nuts (4 required)
- 3/8"-16 X 1" Flat Head steel or stainless steel Allen Screws (2 required)
- 5/16"-24 X 1 1/4" stainless steel bolt
- 5/16"-24 stainless steel nut
- 5/16"-24 wing nuts (2 required)
- #2 Automobile Jumper Cables
- Marine Battery Accessory Connectors with 5/16" NC Stud and Wing Nut
- #2 Compression type Cable Connectors with single 5/16" hole (4 required)

Hardware assembly of the power unit is carried out as follows:

1. Screw a 1/4"-20 nut onto each Threaded Adjustable Glide.
2. On the side having the countersinks, screw a threaded adjustable glide with nut into each 1/4"-20 threaded hole in the 1/2" X 9" X 18" Aluminum Plate (base plate). Screw each glide in to its hole until the end of the screw just exits the plate. Lock each Glide into position with the nut.
3. From the side having the countersinks, insert a 5/16"-24 X 1 1/4" stainless steel bolt. Lock the bolt into position using a 5/16"-24 stainless steel nut tightened down on the other side. Place a 5/16"-24 wing nut onto the exposed screw and tighten by hand. **This is the negative terminal of the power unit.**
4. With the power unit standing on the motor end, place the base plate against the power unit mounting surfaces. Insert the 3/8"-16 X 1" flat head Allen screws into the 3/8" holes and tighten. If the Allen screws do not bottom out in the countersink, remove the screws and grind away enough thread to allow the screw head to bottom out in the countersink. Once the base plate is firmly attached to the power unit, set the power unit assembly on the glides and wrap the hydraulic hose around the power unit to keep it out of the way.
5. Remove the "jumper cable clamps" from the #2 Automobile Jumper Cables and replace each of them with a #2 Compression type Cable Connector having a single, 5/16" hole (connectors with 3/8" holes will work). Use heat shrink tubing to insulate as much of the connector as possible. Although screw type connectors are available, compression type connectors are best for this application because they are tight, light, compact and less likely to cause a short.

At this point, the power unit needs to be filled with fluid, connected to the press assembly, connected to power, and air needs to be purged from the hydraulic system. These activities are accomplished as follows:

1. Using a funnel and a flashlight, fill the tank on the power unit to between 1/2 and 3/4 full of hydraulic oil. The Fenner power unit can use either SAE 10 grade hydraulic oil or Dextron II ATF for temperatures between 0 and 120 degrees F. Make sure the funnel and the oil are clean.
2. Connect the hose on the power unit to the nipple on the Press Assembly. Connect the hose on the Press Assembly to the nipple on the power unit.
3. Connect the white (or red) jumper cable to the positive terminal of the power unit (the lower solenoid stud with the wing nut). Connect the black jumper cable to the negative terminal of the power unit (the stud with the wing nut on the base plate). Place the marine battery accessory connectors onto the terminals of a 12 VDC battery (like an automobile battery) and connect the jumper cables to the studs on the marine battery accessory connectors - white (or red) goes to the positive or "+" terminal, black goes to negative or "-" terminal. Normally, the "+" and "-" are formed into the battery case beside each terminal.
4. Assuming the hydraulic cylinder ram is still extended (as it was after press assembly), the first operation is to retract the ram and purge the air from the upper end of the hydraulic cylinder. For this operation, the nut must be removed from the end of the ram.

   The ram is retracted by moving the control lever to the stop toward the motor end of the power unit. When the control lever is moved to the stop, the power unit motor should make noise. Because there is air in the system, the ram may hesitate before moving. If the motor runs, but the ram does not move, the relief valve pressure may be too low. Remove the relief valve cap and turn the screw clockwise a few turns. Once the ram is completely retracted, immediately release the control lever.
5. Using a flashlight, check the level of hydraulic fluid in the power unit tank. Add enough fluid to half fill the tank.
6. To purge the air from the upper end of the hydraulic cylinder, position the clevis pin end of the press higher than the ram end, extend the ram at least 6" by moving

the control lever away from the motor end of the power unit, and retract the ram.

7. To purge the air from the lower end of the hydraulic cylinder, position the press on its side with the fittings up and the ram end of the hydraulic cylinder higher than the clevis pin end. Extend the ram at least 6", replace the nut on the end of the ram, screw the nut onto the ram until the bottom of the nut is even with the bottom of the ram, and retract the ram until the nut touches the reinforcing plate.

Once the air has been purged from the hydraulic cylinder and the press has been restored to a standing position, the hydraulic press is ready to do work.

When you get to this point, you have an accomplishment to be proud of. Disconnect the cables from the battery and the power unit (always from the battery first), disconnect the power unit assembly from the press assembly, and wait for the next article before attempting to use the press.

The third and final article in this series will address press operation, maintenance, and safety.

A 12VDC HYDRAULIC PRESS
Part 3 of 3

This is the third in a series of three (3) articles on building a 12-volt DC Hydraulic press. The first article described the origin and design of the hydraulic rocket press. The second article described press assembly. This article addresses safe press operation and maintenance.

First off, let me comment on some developments. A new PAT member, Kent Lindsey, has built a press similar to the one described in these articles. If you send me e-mail at mcmurray1329@earthlink.net, I will send you some pictures of Kent's press or you may directly contact Kent.

As an improvement, Kent replaced the ram nut with a "ram end" made from a 2" length of 2" diameter brass stock. One of Kent's contacts fabricated the ram end on an automatic machine tool. I purchased a ram end through Kent. I am pleased with the improvement. Kent has agreed to sell the ram ends for $20.00 or $30.00, depending on the design. Kent can be contacted by telephone at 281-586-7231, by e-mail at rklsr@flash.net, or by Snail-Mail at:

Kent Lindsey
14999 Wunderlich #126
Houston, Texas
77069

The first section of this article addresses safety, the second section addresses press operation, and the final section addresses press maintenance.

SAFETY

Assuming you have followed the previous story (and that I have told it correctly), you now have a portable hydraulic press capable of exerting over 5,000 lbs of pressure on anything placed under the ram or between the ram nut and the top press plate. Ram pressure is always exerted perpendicular to the press plates - both bottom and top. The center of the ram is intended to exert pressure in the center of the bottom press plate; however, if the tooling is slightly off-center, the All-Thread separators will flex to align the ram with the tooling.

The hydraulic press is designed to perform a certain set of tasks. The press performs those tasks well, but there are some common sense safety rules to memorize and remember:

SAFETY RULE 1 - Protect your eyes! When connecting hydraulic hoses to the press or power unit, you can be sprayed with hydraulic fluid. A grain of sand between the ram end and the tooling can shatter under pressure and hit you in the face. Lots of strange things can happen when working with high-pressure equipment.

Eye protection is inexpensive, convenient, and **ESSENTIAL**. If you do not have safety glasses, buy a set and wear them! AND, I do mean **SAFETY GLASSES** - not just "tempered" reading glasses. If you normally wear glasses (as I do), have the lenses made out of safety thickness polycarbonate plastic. Polycarbonate lenses cost a little more, but are scratch resistant, practically indestructible - and worth every penny.

SAFETY RULE 2 - Beware the ram. The list of things you can press is endless. The list includes (but is not limited to) tooling, fingers, toes, elbows, legs, feet, ears, noses, and any other appendage you place below the ram **OR** between the ram nut and the top press plate. If you place your finger (or any other appendage) between the tooling and the ram, there is a good chance that it will be crushed. If you place an appendage between the ram nut and the top press plate, there is also a good chance it will be crushed.

When you handle the ram or the ram nut, make sure that there is no way for the power unit to be activated. If there are observers in the area, move them away from your work area before you handle the ram. One (1) serious mistake can cost you a finger.

SAFETY RULE 3 - Align the tooling with the ram. Place your tooling in the center of the bottom press plate, directly below the center of the ram. The All-Thread separators between the top and bottom press plates allow the press to compensate for minor tool misalignment. Severe misalignment can bend the tooling, bend the ram, and/or cause the tooling to "spring" out from under the ram. Tooling and rams are expensive to replace. Damage caused by a tool exiting the press at high speed may not be repairable.

SAFETY RULE 4 - Keep your work area clean and organized. The bottom press plate is intended as the primary work surface. Do not leave extra tools on the bottom press plate. Store extra tools and tooling behind the press or in your tool box. When not in use, place the tools you are working with (i.e., working tools) into the space between the Press Assembly and the Power Unit Assembly.

Most fuels are extremely flammable and somewhat shock and/or friction sensitive. When pressed between two metal surfaces, fuels can react poorly. In the presence of moisture, some fuels become a sticky, corrosive mess that is hard to get off of your tooling, press, hands, and clothes.

Clean up fuel spills immediately with a brush and/or a damp cloth. When you have fuel on your hands, wash them before beginning the next job.

SAFETY RULE 5 - Separate the Press and Power Unit Assemblies. The hydraulic power unit is connected to a 12-volt battery. The battery does not have enough voltage to shock you or even to feel. HOWEVER, the battery can supply enough current to melt tools and tooling, burn fingers, and, MOST IMPORTANTLY, cause very large sparks. Fuel and sparks in the work area can ruin your entire day.

If you are working on a table or pickup tailgate, position the press on the left side and the power unit on the right side with the operating lever toward you. Keep the fuel on the left side of the press. DO NOT place tooling in front of the power unit. Be careful of the positive, or "+", power unit connection.

SAFETY RULE 6 - Do not keep more fuel in the press area than you need for a job. Most fuels are extremely flammable and somewhat shock and/or friction sensitive.

When ignited, small amounts of loose fuel usually burn without exploding. Anyone in close proximity might be burned, but not dismembered. Large amounts of some loose fuels can explode when ignited. Keep only enough fuel in the press area to do your current job. Keep the remainder of your fuel in a closed container located away from the press area.

As a final comment on safety, remember that the portable hydraulic press is a specialized tool that is designed to do a certain set of jobs in a certain way. With reasonable care, the press does those jobs well. When used carelessly or for jobs it was not designed to do, the press can be dangerous to the operator and to everyone in the area.

PRESS OPERATION

This section addresses actual use of the Hydraulic Press. The section is broken into three (3) subsections: Setup, Operation, and Takedown. **REMEMBER SAFETY RULE 1.**

SETUP - Getting ready for use. In the second article on Assembly, the Hydraulic Press was set up to remove air from the system. This section includes only those steps required to set up the Hydraulic Press. **DO NOT PLACE ANY FUEL IN THE WORK AREA UNTIL THE PRESS SET UP IS COMPLETE.**

1. Select a clean, well-supported, reasonably flat work surface that is large enough to accommodate (from left to right) a small amount of fuel, the Press Assembly, and the Power Unit Assembly. Be sure there is enough space behind the Press Assembly to store excess tooling. **REMEMBER SAFETY RULES 4 AND 5.**
2. Position the Press Assembly on the left side of the work surface. Leave enough space on the left side of the Press Assembly to accommodate a small fuel container. Adjust the "feet" so that the Press Assembly is stable.
3. Position the Power Unit Assembly to the right side of the work surface with the operating lever toward you. Leave enough space between the Press Assembly and the Power Unit Assembly to store your working tools. About 6" is enough space to store your working tools.
4. Inspect the Press Assembly for signs of damage. In particular, check the hydraulic cylinder, hose, and hose coupling for leaks. Check the hose for cuts and abrasion. Clean off oil spots with paper towel.
5. Inspect the Power Unit Assembly for signs of damage. In particular, check for leaks and spilled oil. Check the hose and hose coupling for leaks. Check the hose for cuts and abrasion. Clean off oil spots with paper towel.
6. Connect the hose on the Power Unit Assembly to the nipple on the Press Assembly. Connect the hose on the Press Assembly to the nipple on the Power Unit Assembly. Route the excess hose between and behind the Press and Power Unit Assemblies. Clean off oil spots with paper towel.
7. Connect the white (or red) jumper cable to the positive terminal of the Power Unit Assembly (the lower solenoid stud with the wing nut). Connect the black jumper cable to the negative terminal of the power unit (the stud with the wing nut on the base plate).
8. Install the marine battery accessory connectors onto the terminals of a 12-volt battery (like an automobile battery).
9. Connect the jumper cables to the studs on the marine battery accessory connectors - white (or red) goes to the positive, or "+", terminal, black goes to negative, or "-", terminal. Normally, the "+" and "-" are formed in the battery case beside each terminal. First, connect the black jumper cable to the negative, or "-", terminal stud. Second, connect the white (or red) jumper cable to the positive, or "+", terminal stud.

ALWAYS make the power connections in the order stated in steps 7, 8, and 9.

10. Move the operating lever on the power unit to the left stop and hold it in position until the ram is completely extended. Release the operating lever.
11. After clearing the area of bystanders, inspect the bottom of the hydraulic cylinder and the ram for leaks. Be sure that the ram nut is properly positioned on the ram. **REMEMBER SAFETY RULE 2.**
12. Move the operating lever on the power unit to the right stop and hold it in position until the ram is completely retracted. **REMEMBER SAFETY RULE 2.**

The Hydraulic Press is now set up and ready for operation.

OPERATION - Using the Hydraulic Press

The section titled "SETUP" describes the basic operations of the press. That is, to extend the ram, move the operating lever to the left stop. To retract the ram, move the operating lever to the right stop. To control ram speed, move the operating lever only part way to the left stop or part way to the right stop. This section describes Hydraulic Press operation while constructing a rocket engine. **REMEMBER SAFETY RULE 1.**

1. Adjust the relief valve on the Power Unit Assembly to deliver the pressure needed to do the job. This is accomplished by placing a length of 1" diameter (or greater) metal stock between the ram and the bottom press plate and adjusting the relief valve until the desired pressure reading is achieved. Be sure that the ends of the metal stock are finished flat and at 90 degrees to the length. **REMEMBER SAFETY RULE 2.**

   Place the metal stock under the ram, in the center of the bottom press plate, then lower the ram until it just touches the stock. Remove your hands from the press area and proceed as follows:

a) Move the operating lever to the left stop until the maximum pressure is achieved and immediately release the lever.

b) If the pressure reading on the gauge is lower than the desired pressure, remove the relief valve cover and turn

the relief valve screw clockwise. Restart the procedure and continue until the desired pressure reading is achieved.

c) If the pressure reading on the gauge is higher than the desired pressure:

- Move the operating lever to the right until the pressure reading drops below the desired pressure. Release the operating lever.
- Remove the relief valve cover and turn the relief valve screw counter-clockwise.
- Restart the procedure and continue until the desired pressure reading is achieved.

After the desired pressure reading is achieved, install the relief valve cover and retract the ram. Be careful to properly install the o-ring under the relief valve cover.

2. Select the tooling and the engine casing you wish to use.
3. Inspect the tooling. Make sure that the tooling is properly assembled and all screws are tight. Inspect the drifts and remove any burred edges. Inspect the engine casing for flaws. Do not use a flawed engine casing - destroy it.
4. Place the selected drifts in the working tool space between the Press and the Power Unit Assemblies. **REMEMBER SAFETY RULES 4 AND 5.**
5. Place the engine casing onto the spindle and tool base. Position the casing, spindle, and tool base directly under the ram, in the center of the bottom press plate. The ram should be retracted enough to accommodate the tool base, spindle, and casing with a drift installed. **REMEMBER SAFETY RULE 3.**
6. Using a small, covered container, remove enough fuel from your bulk fuel storage container to fill the engine casing. Replace the cover on the bulk fuel storage container. Place the bulk fuel storage container in a location away from the work area. Place the small container on the left side of the press. **REMEMBER SAFETY RULES 4 AND 6.**
7. Using a measure designed for the engine casing, transfer a measured amount of fuel from the small, covered container into the engine casing. Replace the cover on the small container after each measure of fuel is removed.
8. The measure should hold enough loose fuel to occupy a length of engine casing equal to the inside diameter. That is, the measure for a 1" inside diameter engine casing should hold enough loose fuel to occupy a 1" length of the casing. The measure for a 1 1/2" inside diameter engine casing should hold enough loose fuel to occupy a 1 1/2" length of the casing. A copper tubing cap silver soldered to an 8" length of 1/4" diameter brass rod works well as a fuel measure.
9. Insert a drift into the engine casing on top of the loose fuel. Place the drift, engine casing, spindle, and tool base under the ram, in the center of the bottom press plate.
10. Lower the ram until it just touches the drift, remove your hands from the press area, move the operating lever to the left stop, and immediately release it. **REMEMBER SAFETY RULE 3.**
11. Wait about ten (10) seconds or until the pressure gauge reading stabilizes. Again, move the operating lever to the left stop and release it. Repeat this step until the pressure change on the gauge is small.
12. Retract the ram enough to remove the drift, engine casing, spindle, and tool base.
13. Remove the drift and repeat steps 7 through 11 until the engine casing is filled to within 1/4" of the top edge.

At this point, you have a completed rocket engine AND you can build many more exactly like it. Remove the engine from the tooling, strap on a stick, light it off, and watch it fly. You can be very proud of your press and the engines that you build.

TAKEDOWN - Disassembly after use

Each time you finish using your Hydraulic Press, it should be carefully disassembled, cleaned, and made ready for storage. This section addresses disassembly after use. The section titled "MAINTENANCE" addresses cleaning and storage.

Use the following procedure to disassemble your Hydraulic Press:

1. Retract the ram into the hydraulic cylinder. Although the ram is chrome plated, it should be retracted for storage.
2. Disconnect the jumper cables from the battery. **ALWAYS DISCONNECT THE POSITIVE, OR "+", CABLE FIRST.** Disconnect the white (or red) jumper cable from the stud on the marine battery accessory connector on the positive, or "+", battery terminal. Replace and tighten the wing nut on the stud. Disconnect the black jumper cable from the stud on the marine battery accessory connector on the negative, or "-", battery terminal. Replace and tighten the wing nut on the stud.
3. If the battery is not dedicated to the Hydraulic Press, remove the marine battery accessory connectors from the battery terminals.
4. Disconnect the jumper cables from the Power Unit Assembly. Remember to replace and tighten the wing nuts. Carefully roll up the jumper cables and store them in a plastic bag along with the marine battery accessory connectors.
5. Carefully disconnect the hydraulic hoses between the Press Assembly and the Power Unit Assembly.

   Disconnect both quick disconnect couplers. Be careful to prevent dirt or moisture from entering the fittings. As soon as a quick disconnect coupler is removed, carefully wipe the hydraulic oil off of the quick disconnect nipple

with a clean cloth or a clean paper towel. Immediately connect the quick disconnect coupler to the quick disconnect nipple on the same Assembly. To keep the hoses out of the way during transport, wrap the hose on each Assembly around the Assembly to which it is permanently attached.

If dirt gets into a quick disconnect coupler, carefully clean the coupler with clean solvent and a clean cloth or cotton swab. Moisture may be removed with a clean cloth or cotton swab. **BE SURE TO GET ALL OF THE MOISTURE AND EVERY GRAIN OF DIRT OUT OF THE CONNECTOR.** Anything that gets into your hydraulic system will stay there forever and eventually kill the hydraulic components.

6. Clean up any oil or fuel spills on the Hydraulic Press with paper towel and/or a damp cloth. Remove the Press and Power Unit Assemblies from the work surface. Clean the work surface. Pick up any litter in your work area and take it with you. Leave the work surface and work area cleaner than you found them.

MAINTENANCE

The Hydraulic Press is made from heavy-duty components. The hydraulic cylinder is used in agricultural applications where exposure to dust and weather is common. The power unit is used on delivery trucks where it is exposed to both dust and weather. The power unit reservoir air breather is zinc plated and designed to keep both debris and water out of the reservoir. The power unit base plate is made from aluminum and attached with stainless steel screws. The hose couplings are zinc plated and intended for outside applications. The hoses are intended for use in outside applications. The All-Thread, nuts, bolts, and washers are either zinc plated or made from stainless steel. In summary, the Hydraulic Press components are designed to survive outside applications. Thus, even when exposed to the elements, the Press requires little maintenance.

The Hydraulic Press has some cosmetic weak spots requiring special care. In particular, the paint on the power unit is not the best. After two (2) years of mostly outside storage and some weather exposure, most of the paint on the valve manifold has peeled and the metal severely rusted. The exposed portion of the manifold valve operating rod (connected to the operating lever) and the All-Thread separators are rusting. Tooling has removed the paint from the top surface of the bottom press plate and the steel is rusting from exposure to the salts in the fuel combined with moisture. In summary, all of these areas require special care.

After using your Hydraulic Press, I recommend that you wash the Press Assembly with soap and water to remove all traces of fuel. You can use the local car wash. Soap it down and rinse it with hot water. Let it stand in the sun until it is dry. Give the top of the bottom press plate a light coat of oil or wax. Carefully clean the Power Unit Assembly with a damp cloth and/or a brush to remove any fuel from the painted surfaces. Carefully clean the manifold, manifold valve operating rod, and operating lever with a damp cloth and/or a brush. Let the components dry and give them a light coat of oil.

I strongly recommend that your Hydraulic Press be stored inside, out of the weather. The storage area need not be climate controlled, but it should be reasonably dry. To keep off the dust, your Hydraulic Press can be covered with large garbage bags.

If you have questions about the 12-Volt DC Hydraulic Press or comments on the these articles, please contact me by phone at 972-723-1444, by E-Mail at mcmurray1329@earthlink.net, or by Snail-Mail at:

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